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ABSTRACT

This paper highlights the results of an investigation of preservice elementary teachers' perceptions of their ability and preparation to teach via technology. Results indicated that participants tended to perceive themselves as capable of teaching via technology. However, they had difficulty identifying specific technological resources for teaching. Further, participants tended to be less positive in their perceptions of both the extent to which their degree program prepared them to teach via technology and the extent to which their instructors modeled the effective use of technology. Accordingly, modifications to teacher education programs may be warranted and some suggested alterations are provided. (Contains 11 references.) (Author/SM)

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"It should have been stressed in all education classes." Preparing pre-service teachers to teach with technology

Michael D. Hardy

Abstract: This paper highlights the results of an investigation of pre-service elementary teachers' perceptions of their ability and preparation to teach via technology. Results indicated that participants tended to perceive themselves as capable of teaching via technology. However, they had difficulty identifying specific technological resources for teaching. Further, participants tended to be less positive in their perceptions of both the extent to which their degree program prepared them to teach via technology and the extent to which their instructors modeled the effective use of technology. Accordingly, modifications to teacher education programs may be warranted and some suggested alterations are provided.

Introduction

About five years ago, I began to wonder if the pre-service teachers in my methods classes were being adequately prepared to use technological resources as instructional tools. These questions arose from criticisms voiced by pre-service teachers about how little was learned in educational technology courses. Accordingly, I periodically asked my students what they studied in their educational technology course. I feared that they were only being taught fundamentals of operating a computer, how to create a spreadsheet, use a grading program, and how to create a multi-media presentation. These are certainly valuable skills, but they are insufficient to adequately prepare teachers to teach via technology. Accordingly, I was dismayed when my pupils substantiated my fears and have continued to do so over the past five years. A review of literature revealed that others were similarly concerned with what appeared to be an over-emphasis on basic computer skills, spreadsheets, and multi-media presentations in pre- and in-service programs designed to prepare teachers to teach with technology (Dusick, 1998; Topp, 1996). Relevant literature also indicated that many teachers' have inadequate knowledge of technological resources, methods of teaching via such resources, and methods of assessing such

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activities (National School Board Foundation (NSBF), 2002; Hoffman, 1997; Roblyer & Erlanger, 1999; Education Technology News, 1999).

In the spring of 2000, I began an investigation of 43 pre-service elementary teachers' beliefs concerning their ability to use technological resources as teaching tools. The goal of this study was to identify patterns in pre-service teachers' perceptions of their ability to use technology as an instructional tool or resource as well as in their perceptions of how their degree program prepared or failed to prepare them to teach via technology. Patterns in the data were used to highlight potential strengths and weaknesses in teacher preparation programs and served as the basis for recommendations for such programs.

Theoretical Framework

This study is descriptive in nature (Gay, 1996), so its primary role is to describe one situation in order to spark discussion, research, and if appropriate, change in the nature and content of teacher preparation programs. However, the study is critical or informed by the emancipatory interest (Habermas, 1978) in the sense that it raises the question of whether or not teacher preparation programs as they are currently structured are adequately preparing pre-service teachers' to teach through technology. Further, the paper explores the adequacy of pre-service teachers' pedagogical knowledge (Shulman, 1987). Accordingly, I will address potential implications that the data have for methods of preparing pre-service teachers to teach via instructional technology. Nevertheless, it is up to the reader to determine the relevance of these findings and recommendations for the context in which he or she prepares teachers.

Participants

The participants in this study were 43 pre-service elementary teachers who were about 10 days from completing their undergraduate course of study at a university of approximately 12,000

students in the south-central United States. The degree program was structured in such a way that cohorts of elementary education majors took fixed blocks of courses during their senior year. The participants of this study were nearing the end of their senior block of courses, which for most of the participants, was a precursor for a fifth year of study and a concurrent 2-semster internship that would lead to a Master of Arts of Teaching in Elementary Education. However, at the time of the study, none of the participants had completed an internship.

Of the 43 participating pre-service elementary teachers, 27 were my pupils. Of these, 7 were from one instructional methods course and 20 from another. The courses were intended to be integrated across disciplines, and I was responsible for teaching the component that focused on instructional methods for mathematics. However, my colleagues and I were rarely in the classes at the same time. Accordingly, I do not claim that the methods course was integrated across disciplines to the extent that the boundaries between the disciplines were blurred, but my colleagues and I did endeavor to establish links between content areas and between some of our lessons.

Aside from myself, I shall refer to the participants' instructors as Mr. K, Ms. L, Ms. M, Ms.N, and Mr. O. Ms. L, was responsible for teaching the language arts components for both courses with which I interacted. Mr. K taught the social studies and science components for 20 of my pupils and Mr. O taught the corresponding components for the remaining 7 of my pupils. The rest of the participants were taught methods of teaching mathematics by Ms. M and language arts, social studies and science methods by Ms. N.

Methods

Data was collected through a survey developed by the principal investigator that contained both 5-point Likert scale and open-response items. No data is available concerning the validity or

reliability of the questionnaire. The survey appeared to be reasonably valid based on the observed compatibility between the survey questions and the participants' responses. Frequency counts, percentages, and chi-square tests were used to identify patterns in Likert scale data, and open-response items were assigned to 1 or more groups on the basis of response similarity. A significance level of $\alpha = 0.05$ was used in all analyses.

As noted above, my focus was on determining if the participating pre-service teachers perceived themselves to be prepared to use technology as a teaching tool. As a check on these perceptions, I asked participants to site three specific technological resources for teaching each of the disciplines of mathematics, science, social studies and language arts. Finally, after the need arose, semi-formal interviews were conducted by phone and email to collect data concerning the methods through which the participants' instructors integrated technology into their instruction.

It should be noted that I began the study with the tentative hypothesis that the pre-service teachers would not perceive themselves as ready to teach via technology. I also suspected that the participants would tend to disagree with the statements that their teacher preparation program prepared them well for teaching via technology and that their instructors modeled the effective use of instructional technology. However, the hypotheses were tentative, and I accepted that it was very possible that they were erroneous.

Results

Participants' Self-Perceptions

Analysis indicates that the participating pre-service elementary teachers generally perceived themselves as capable of teaching through technology (≈83% Agree or Strongly Agree & 100% Neutral to Strongly Agree), view the integration of technological resources into

instruction as important (≈ 95% SA or A) and intend to incorporate technology in their teaching on a daily to weekly basis (≈ 93%). All of the participants indicated they could use the Internet to locate lesson plans or information relevant to a lesson, and virtually all indicated they could download information from the Internet (93% SA or A). A little less than half of the participants stated they could use the Internet to locate another class with which their pupils could correspond (46.5% SA or A), and just over half asserted they could create a web page for instructional purposes (51.2%). Most of the pre-service teachers' responses indicated that they could use *Power Point* or *HyperStudio* to create a multi-media presentation (83.7% SA or A). Over half maintained that they could effectively incorporate the use of spreadsheets into their instruction (65.1% SA or A) and that they could effectively incorporate a database into their instruction (55.8%). The majority (62.8% SA or A) also reported that they could use a scanner or digital camera to prepare instructional aids, and just over 2/3 of the participants (69.8% SA or A) asserted they could effectively use software as a major component of a lesson. Additionally, 88.4% (SA or A) indicated that they could effectively use a laser disc as a major component of a lesson. These data are generally positive, although there is room for improvement in the percentages for several categories.

Knowledge of Specific Resources

General trends. While the participants' perceptions of their preparedness to teach via technology was generally positive, not all of the data was encouraging. When asked to list five technological resources with which they had become familiar through their education courses, participants listed resources such as the Internet, email, *Power Point*, spreadsheets, software and videos, but 37.2% of the respondents could not list five such resources. When asked to identify three specific technological resources for each of the disciplines of mathematics, science,

language arts and social studies, most participants again listed 2 or 3 broad categories of technological resources such as the Internet, videos and email; however, the Internet, software, videos and laser discs were noted on the questionnaire. Further, the pre-service teachers had great difficulty listing even one specific title for any of the 4 disciplines. Only 8 of 43 or 18.6% were able to list at least one specific title or website. However, 16 more participants for a total of 24 or 55.8% of the participants did provide a response that indicated some knowledge of specific technological resources or where to locate them. Likewise, 60.5% of the participants were able to give a response the indicated at least some knowledge of a specific technological resource or provided a description in general terms of how a category of technological resources could be used as an instructional aid for a purpose other than locating lesson plans[1]. On the surface, these percentages appear positive; however, I believe most educators would want a much higher percentage of graduating pre-service teachers to display pedagogical knowledge of technological resources.

An underlying factor. The participants' difficulty in listing technological resources may simply have reflected a difficulty in remembering the titles of the resources to which they had been exposed, but it could also be indicative inadequate knowledge of and experience with technological resources and methods of teaching through them. To make such a claim solely on the basis of the preceding percentages would be tenuous at best. However, an intriguing trend underlying the percentages leads me to suspect both that another factor may have impacted the results and that the percentage of the participants displaying knowledge of specific resources may be misrepresentative of the knowledge of each of two subgroups of respondents. As stated above, 24 participants' responses indicated some knowledge of specific technological resources or where to find them. This set of 24 participants entailed 8 who were able to identify at least 1

specific technological resource that could be used to teach one or more disciplines. However, 16 of the 24 or 75% of those displaying some awareness of specific technological tools came from one class that comprised only 46.5% of the participants. Likewise, 5 of the 8 or 62.5% of those citing specific resources were from that class.

The factor that appears to be unique to the class comprising the bulk of respondents displaying awareness of specific resources was Mr. K. Mr. K was involved in teaching only the group that displayed the high percentages of awareness of resources. These pupils were also taught by myself and Ms. L. However, Ms. L, Mr. O, and I all taught a class containing 7 other participants, but those pupils did not display the same level of knowledge as Mr. K's pupils. Two different instructors, Ms. M and Ms. N taught the remaining 16 participants, and those students also displayed less knowledge of technological resources than Mr. K's pupils.

In light of this apparent difference in awareness of resources, participants I separated the participants into 2 groups, those who were and those who were not Mr. K's students and reexamined the issue of ability to site a specific technological resource. I found that 5 of 20 or 25% of Mr. K's pupils were able to highlight a specific technological tool, while 3 of 23 or 13% of the remaining participants were able to do likewise. Further, 16 of 20 or 80% of Mr. K's students displayed at least some awareness of specific technological resources or where to locate them, while only 8 of 23 or 34% of the rest of the participants displayed awareness of specific resources or where to locate them. A χ^2 test for homogeneity using $\alpha = 0.05$ level of significance does not reveal a statistically significant ($p = 0.32$) difference in the relative frequency of occurrence of participants in Mr. K's class who could identify a specific technological tool. However, a similar χ^2 test does reveal that the relative frequency with which Mr. K's students displayed at least some knowledge of a specific technological resource or its location is

significantly higher ($p = 0.003$) than for other students. Thus, there was a relationship between being a pupil of Mr. K and demonstrating some awareness of specific technological resources or their location.

On a related note, a χ^2 test for homogeneity using $\alpha = 0.05$ level of significance does not reveal a statistically significant ($p = 0.07$) difference in the relative frequency of occurrence of participants in Mr. K's class who described in general terms a method of teaching via a class of technological resources (software, videos, etc.) or displayed knowledge of a specific technological tool. However, as previously noted the inability to reject the null hypotheses could be due to low power resulting from the small number of participants. But, even if the null could be rejected, any difference in performance could be due to the previously established advantage in ability to identify specific resources rather than more proficiency in describing methods of teaching with technology. Thus, future investigations should entail a separate item asking participants to describe a method of teaching with technology.

The nature of the difference. Having established Mr. K's pupils' superior ability to display at least some knowledge of technological tools or their location, I will now endeavor to shed some light on the nature of that advantage. Based on participant responses to requests to list 3 specific technological resources for teaching each of the disciplines of mathematics, science, social studies, and language arts, it appeared that Mr. K's pupils were more adept than other participants at highlighting websites that could be used as educational resources. Six of Mr. K's 20 pupils displayed at least some knowledge of a specific website while only three of the remaining 23 participants displayed such knowledge. Likewise, five of Mr. K's students displayed at least some knowledge of at least two specific websites versus two of the remaining participants. Four of Mr. K's pupils displayed knowledge of at least 3 websites while only 1 of

the remaining participants exhibited such knowledge, and three of Mr. K's students noted four specific websites verses zero of the remaining participants.

None of the preceding frequencies are particularly desirable, but the fact that Mr. K's pupils had an advantage in every case is intriguing. A χ^2 test for homogeneity with $\alpha = 0.05$ level of significance does not reveal a significant difference in the relative frequency with which Mr. K's students and the rest of the participants displayed knowledge of at least 1, 2, 3 or 4 specific websites. Even so, it is worth noting that the observed significance level (p-value) in the case of 4 specific websites was less than 0.1 ($p = 0.055$).

A potential reason for the difference. The fact that the Mr. K's pupils had a slight but not statistically significant advantage in their ability to list websites that could be used as instructional resources may be coincidence, but it may also be the product of the extent to which Mr. K integrated the Internet into his instruction and assignments. Mr. K created a *WebCT* site for the integrated methods course in which the participants were enrolled. On that site, Mr. K placed plans for activities and links to websites for teaching mathematics, science, social studies and language arts. He additionally required his students to complete or explore and then critique at least 25 of the more than 50 activities and websites he had listed. Mr. K's students were also expected to respond to discussion questions that were posted on his web page as well as to other students' responses, and to submit via email thrice-weekly reflections on their educational experiences. Mr. K also taught his pupils how to create *Power Point* presentations by modeling the synthesis of slides and then having his students construct similar presentations, often in a lab setting. Finally, Mr. K. demonstrated interactive games and CD-ROMs that contained video footage of experiments and printable guidelines for conducting the experiments.

All of the instructors of the participants' methods courses had the opportunity to have access to a *WebCT* site, but the instructors for one group of pre-service teachers chose not to use it. However, their students had access to Mr. K's website, and Mr. K did teach those participants how to access the site. Unfortunately, nothing is known of how often they used Mr. K's site. For the two classes whose instructors did use *WebCT*, it should be noted that each course site contained pages for each instructor to post assignments and information.

Interviews with the 4 of the participants' 6 instructors and my own reflections provided data concerning how the instructors sought to incorporate technology into their pedagogy. Ms. L, an instructor who taught the 2 of the 3 sets of pre-service teachers, including Mr. K's pupils stated that she "did not do as much as" Mr. K (personal communication, 7/31/02), but did strive to familiarize her students with the website and associated links of an international literacy organization. Further, I taught the same pupils as Ms. L, and I posted discussion questions on the course website to which pupils were to respond. On one occasion, I demonstrated three to five pieces of educational software, and on another, I took pupils to a computer lab to explore websites and surf for resources available via the Internet. Mr. O, who did not teach any of Mr. K's students, could not be contacted, but it is believed that he integrated technology into his instruction via methods that were similar to those I used.

Ms. M had her pupils write two critiques of software, periodically made use of some calculator activities, and "over time" had her pupils plan lessons that incorporated the use of websites. She also assigned her students the task of compiling a list of 20 websites at which instructional resources were located. Ms. N similarly had her pupils search the Internet for instructional resources and generate an annotated list of 40 websites that could serve as instructional resources. She also took her students to a computer lab and had them select, review

and critique at least five programs. Finally, a few times during the semester, Ms. N required her pupils to email her responses to discussion questions, and may have occasionally made a *Power Point* presentation.

Based on the preceding reflections of the instructors who could be contacted, it appears that Mr. K used his site and modeled the use of technological resources more consistently and more extensively than the participants' other instructors. This coupled with the fact that Mr. K required his pupils to explore or complete and critique at least 25 of the 50 or more websites or activities that he either posted or for which he provided a link on his *WebCT* page could indicate that consistently requiring pupils to explore, use and critique technological resources is a viable method of facilitating the construction of much needed knowledge about such resources (Bailey & Pownell, 1998; Benson, 1997; Dusick, 1998; Roblyer & Erlanger, 1999; Topp, 1996). However, other instructors did use methods similar to those employed by Mr. K, but they did not obtain similar results. This may be due to more consistent use of exploration and critique, but it may also be due to differences in the students themselves. Of course, consistency in use is no guarantee of learning or retention, as could be evidenced by the fact that the one instance in which Mr. K's pupils were outperformed, although not at a statistically significant level ($p=0.32$) was in highlighting email as an instructional tool despite the fact that he used email more consistently than any of the participants' instructors. However, the difference could reflect Mr. K's students' broader knowledge of resources rather than a failure to consider email an instructional aid.

Participants' Perceptions of Their Preparation to Teach via Technology. Although the participating teachers tended to be positive in their perceptions of their own abilities to teach via technology, they were not as positive in their evaluation of the extent to which their university

prepared them to use technology as an instructional tool (Strongly Agree ≈ 7%, Agree ≈ 28%, Neutral ≈ 37%, Disagree ≈ 21%, Strongly Disagree ≈ 7%). Likewise, the participants tended not to agree as strongly when asked if their instructors had modeled the effective use of technology (SA ≈ 7%, A ≈ 39.5%, N ≈ 41.9%, D ≈ 11.6%). Even so, 46.5% of the participants also noted that they were given assignments such as developing *Power Point* presentations, which would certainly contribute to the participants' preparation to use technology as an instructional tool. Additionally, 39.5% of the pre-service teachers noted that some instructors did incorporate technology in their teaching. Thus it appears that the participants' current and/or prior instructors did strive to incorporate technology into their instruction.

Nevertheless an inadequacy in the extent to which teacher educators effectively modeled or taught the use of technology as an instructional tool was highlighted by 60% of the participants in an open-response question concerning how the university had failed to prepare the participants to teach with technology. Further, 83.7% of the participants indicated they did not receive enough instruction regarding methods of using technological resources to teach a concept or process, which made it the most frequent criticism of the preparation program. Similarly, 44.2% of the pre-service teachers highlighted having only one course dealing with technological resources as a weakness of their degree program. Topp (1996) and Robleyer and Erlanger (1999) also reported pre-service teachers as being dissatisfied with the extent to which teacher educators had infused technology into their practice. Accordingly, it appears that teacher educators need to reflect on the methods through which they teach via technology and take steps to alter their instruction to be more effective in this regard.

Additional Implications & Potential Solutions

The pre-service teachers' perceptions of their comfort with computers, their ability to use the Internet as an instructional resource, and their ability to create spreadsheets and multi-media presentations in conjunction with their claims that their educational technology courses and some subsequent courses emphasized these same topics indicate that those courses did an excellent job of preparing or at least of helping the teachers to feel prepared in those regards. However, the fact that 83.7% of the participants noted a need for additional instruction in methods of teaching via technology suggests that teacher educators need to reconsider the nature and scope of teacher preparation programs. Additional support for this conclusion is found in the pre-service teachers' assertions that the instructors in their degree program inadequately modeled the effective use of technology (60%) and that having only one course focusing on technology was a weakness of their degree program (44.2%).

However, the diversity in the certification levels and specialization areas of the students taking educational technology courses make it impossible for one such course to adequately prepare pre-service teachers to teach via technology. Even so, I am of the opinion that pre-service teachers should be exposed to some technological resources for teaching mathematics, science, language arts, social studies and possibly other disciplines during their educational technology courses. Likewise, such courses should address criteria for selecting and evaluating technological resources as well as some general guidelines for using technology for instructional purposes.

Nevertheless, the burden for preparing pre-service educators to teach through technology cannot fall totally on the instructors of educational technology courses. Methods courses should also address guidelines for selecting and using instructional technology (Topp, 1996) as some elements of such guidelines may differ across disciplines. At this point, I want to reiterate that

several of the participants instructors occasionally demonstrated or provided an opportunity to explore software or websites and had pupils respond electronically to discussion questions on the Internet. Nevertheless, the percentage of Mr. K's students displaying at least some knowledge of specific resources or where to locate them was significantly greater that the percentage of the remaining participants displaying such knowledge. Further, the instructors' reflections indicated that the primary difference in instructional methods was the consistency with which Mr. K incorporated technology into his lessons and assignments. Thus, it appears that only occasionally assigning critiques of resources or occasionally demonstrating resources or providing brief opportunities to explore technological resources are insufficient to prepare pre-service teachers to teach via such resources (Roblyer & Erlanger, 1999). Accordingly, it appears that pre-service teachers need to consistently and extensively explore and evaluate technological resources and to experience the use of software and other technological resources from the perspectives of both learner and instructor (Bailey & Pownell, 1998; Benson, 1997; Dusick, 1998; Roblyer & Erlanger, 1999; Topp, 1996), for it takes time to learn to teach via technology.

Based on my intuition, Mr. K's practice, and Dusick's (1998) recommendations, I propose that one method of helping students to become familiar with technological resources is to consistently have pre-service teachers review and critique such tools. Assignments of this nature have the added bonus of needing to address guidelines for evaluating technological resources. Likewise, I posit that if in their methods and content courses, pre-service teachers used a variety of technological tools (software, Internet, laser disks, DVD's, videos, calculators, etc.) to resolve problems, practice skills, and learn or apply concepts and procedures, their knowledge of such resources and teaching methods would be positively impacted. Finally, I assert that pre-service teachers' knowledge of technology and methods of teaching through it

could be broadened by planning *and* teaching lessons in which technology is used as an instructional tool. Such assignments would not unduly expand the scope of methods courses but would be more likely than demonstrations to help students remember the titles, benefits and weaknesses of numerous technological resources.

Summary

Herein, I have sought to highlight patterns in the perceptions of pre-service elementary teachers' perceptions of their readiness or existing capacity to teach via technology. Data indicated that the participants generally perceived themselves as capable, but had difficulty identifying specific technological resources that could be used as instructional tools. Further, while participants tended to find their educational technology course useful, they often asserted it was the only or virtually the only course in which they learned about technological resources and teaching with them. Accordingly, the pre-service teachers frequently made reference to a need for more instruction on methods of teaching via technology and often criticized their instructors for failing to model such practice. However, the participants also frequently noted that some instructors did try to incorporate the use of technology into their courses and instruction, which is encouraging. Nevertheless, it appears that teacher educators may need to revise teacher preparation programs to better incorporate instructional technology and to provide pre-service teachers with more experience with technological resources as both a learner and instructor. However, the trends noted above may not be widespread. Thus, there is a need for further investigation of all levels of in- and pre-service teachers' perceptions of their ability to teach via technology.

End Notes

1. The participants displaying knowledge of a specific technological resource were included with those who provided a general description of an instructional use of technological resources

because the survey item requested specific titles and because knowledge of such titles does not preclude pedagogical knowledge of the resources.

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